Benthic TMDL Development:

Stressor Identification for South Run, Virginia

Submitted to

Virginia Department of Environmental Quality

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DRAFT REPORT

1.0 Introduction

Total Maximum Daily Load (TMDL) development for biological impairment requires a methodology to identify impairment causes and to determine pollutant reductions that will allow streams to attain their designated uses. The identification of the pollutant(s), or *stressor(s)*, responsible for the impaired biological communities is an important first step in developing a TMDL that accurately specifies the pollutant load reductions necessary for the waterbody to comply with Virginia's water quality standards. This report details the steps used to identify and characterize the stressor(s) responsible for biological impairments in South Run, Virginia. The first section of this report presents the regulatory guidance and defines the applicable water quality criteria for biological impairment. In the subsequent sections of this report, watershed and environmental monitoring data collected on South Run are presented and discussed. Stressors which may be impacting the creek are then analyzed in the stressor identification section. Based on this analysis, candidate stressors impacting benthic invertebrate communities in the creek are identified. A TMDL will be developed for the stressor identified as the primary source of biological impairment in South Run.

1.1 Regulatory Guidance

Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are exceeding water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and instream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 2001).

The state regulatory agency for Virginia is the Department of Environmental Quality (DEQ). DEQ works in coordination with the Virginia Department of Conservation and Recreation (DCR), the Department of Mines, Minerals, and Energy (DMME), and the Virginia Department of Health (VDH) to develop and implement a more effective TMDL process. DEQ is the lead agency for the development of TMDLs statewide and focuses its efforts on all aspects of reduction and prevention of pollution to state waters. DEQ ensures compliance with the Federal Clean Water Act and the Water Quality Planning Regulations, as well as with the Virginia Water Quality Monitoring, Information, and Restoration Act (WQMIRA, passed by the Virginia General Assembly in 1997), and coordinates public participation throughout the TMDL development process. The role of DCR is to initiate non-point source pollution control programs statewide through the use of federal grant money. DMME focuses its efforts on issuing surface mining permits and National Pollution Discharge Elimination System (NPDES) permits for industrial and mining operations. Lastly, VDH classifies waters for shellfish growth and harvesting, and conducts surveys to determine sources of contamination (DEQ, 2001).

As required by the Clean Water Act and WQMIRA, DEQ develops and maintains a listing of all impaired waters in the state that details the pollutant(s) causing each impairment and the potential source(s) of each pollutant. This list is referred to as the Section 303(d) List of Impaired Waters. In addition to Section 303(d) List development, WQMIRA directs DEQ to develop and implement TMDLs for listed waters (DEQ, 2001). DEQ also solicits participation and comments from watershed stakeholders and the public throughout the TMDL process. Once TMDLs have been developed and the public comment period has been completed, the TMDLs are submitted to EPA for approval.

1.2 Impairment Listing

South Run was initially listed on Virginia's 1998 Section 303(d) List of Impaired Waters (DEQ, 1998) and was subsequently included on Virginia's 2002 Section 303(d) List of Impaired Waters and in the 2004 Water Quality Assessment 305(b)/303(d) Integrated Report (DEQ, 2002; 2004) because of violations of General Standard (benthic

impairment). South Run was also listed on the 2004 Water Quality Assessment 305(b)/303(d) Integrated Report due to exceedances of the water quality standards for fecal coliform bacteria. This report addresses the benthic impairment; the bacteria impairment will be addressed in a separate TMDL report. Biological assessments conducted at DEQ monitoring station 1ASOT001.65, located at the intersection of South Run and Route 215, indicate an impaired benthic macroinvertebrate community, which resulted in the Section 303(d) listing.

South Run is located in the northern region of Virginia, and is a tributary of Broad Run in the Occoquan River drainage. The majority of the South Run watershed is located in Fauquier County, Virginia; South Run flows through Fauquier County and into Prince William County, Virginia prior to its confluence with Broad Run. The impaired benthic segment of South Run (VAN-A19R-04) is 2.34 miles in length, beginning immediately downstream of Lake Brittle, and ending at the confluence of inundated waters of Lake Manassas. **Figure 1-1** depicts the impaired segment of South Run, as well as the delineated watershed boundary.

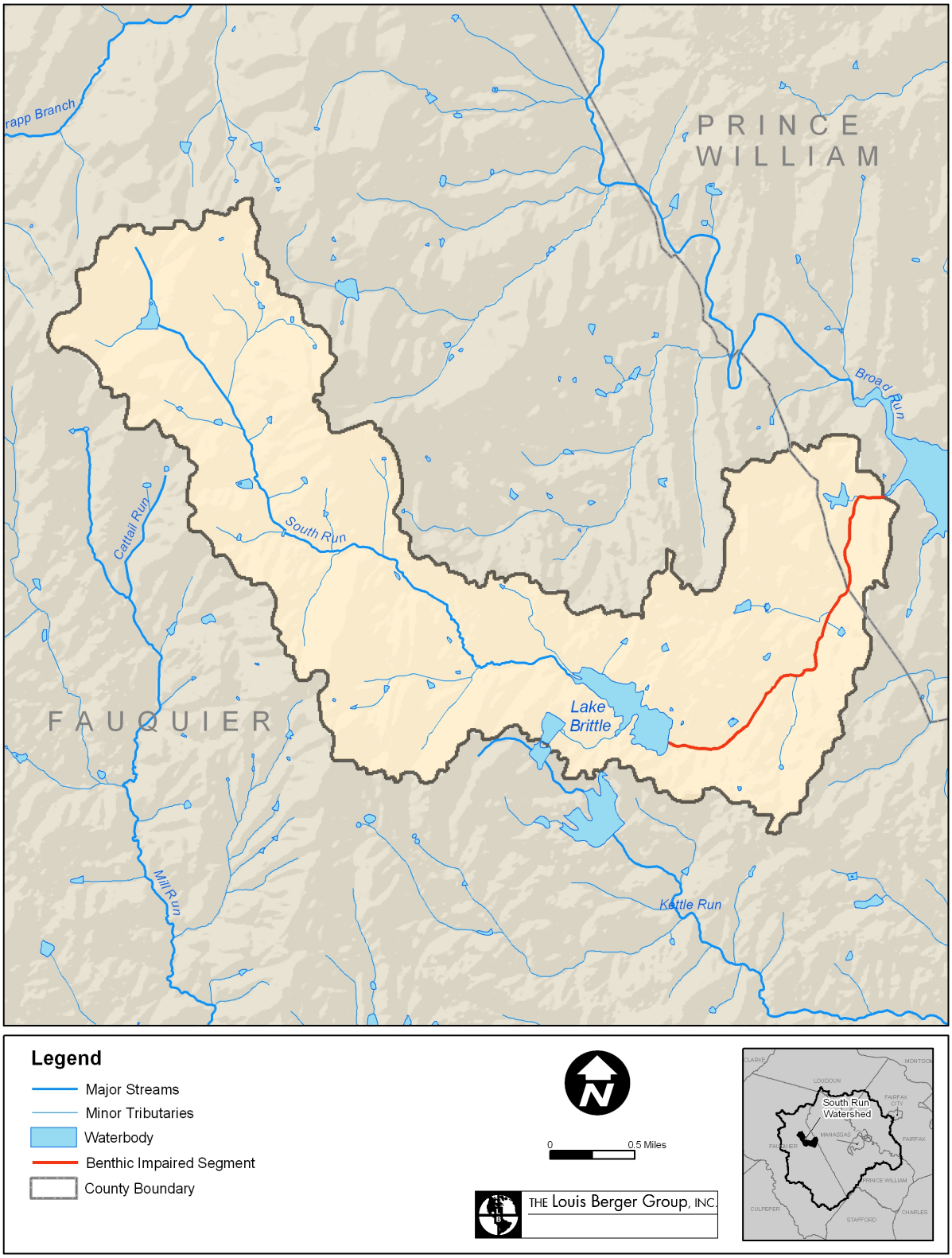

Figure 1-1: South Run Impaired Segment and Delineated Watershed

1.3 Applicable Water Quality Standard

Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. According to Virginia Water Quality Standards (9 VAC 25-260-5), the term *water quality standards* "means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."

1.3.1 Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10):

> *"all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."*

The listed segment defined in Section 1.2 does not support the propagation and growth of aquatic life in South Run, based on the biological assessment surveys conducted on the creek.

1.3.2 Water Quality Criteria

The General Standard defined in Virginia Water Quality Standards (9 VAC 25-260-20) provides general, narrative criteria for the protection of designated uses from substances that may interfere with attainment of such uses. The General Standard states:

> *"All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or*

interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life."

The biological assessments conducted on South Run indicate that some pollutant(s) are interfering with attainment of the General Standard, as impaired invertebrate communities have been observed in the listed segment of the creek. Although biological assessments are indicative of the impacts of pollution, the specific pollutant(s) and source(s) are not necessarily known based on biological assessments alone.

2.0 Watershed Characterization

The physical conditions of South Run were characterized using a geographic information system (GIS) developed for the watershed. The purpose of the characterization was to provide an overview of the conditions in the watershed related to the benthic impairment present in the listed segment of the creek. Information contained in the watershed GIS was used in the stressor identification analysis, as well as for the subsequent TMDL development. In particular, physical watershed features such as topography, soils types, and land use conditions were characterized. In addition, the number and location of permitted discharge facilities and DEQ monitoring stations in the watershed were summarized.

2.1 Physical Characteristics

Important physical characteristics of the South Run watershed that may be contributing to the benthic impairment were analyzed using GIS coverages developed for the area. GIS coverages for the watershed boundary, stream network, topography, soils, land use, and ecoregion of the watershed were compiled and analyzed.

2.1.1 Watershed Location and Boundary

The majority of the South Run watershed is located in Fauquier County, Virginia; South Run flows through Fauquier County and into Prince William County prior to its confluence with Broad Run (**Figure 2-1**). The watershed is approximately 4,475 acres or 7.0 square miles.

2.1.2 Stream Network

The stream network for the South Run watershed was obtained from the USGS National Hydrography Dataset (NHD). The stream network and benthic impairment segment are presented in **Figure 2-1**.

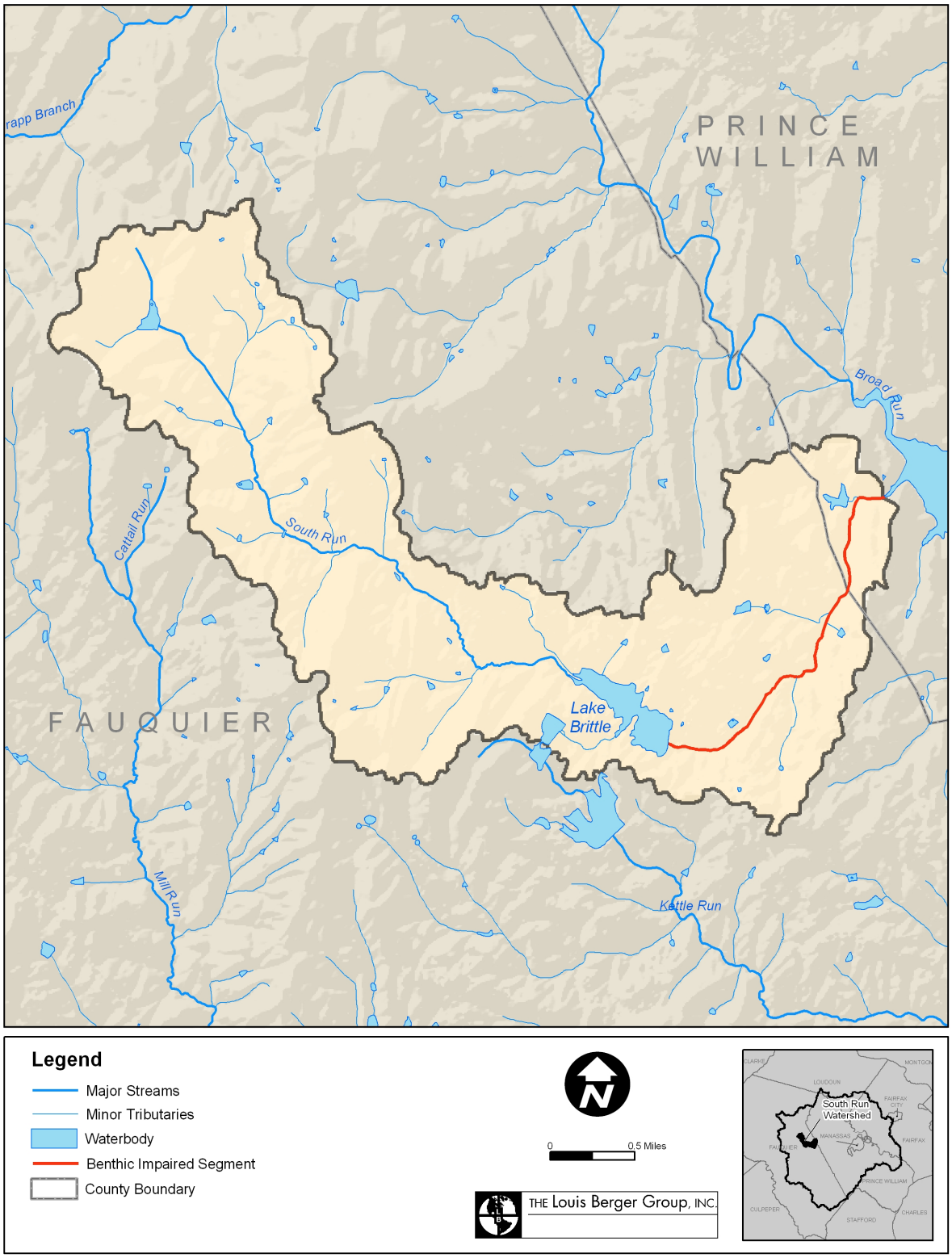

Figure 2-1: Stream Network for the South Run Watershed

2.1.3 Topography

A digital elevation model (DEM) was used to characterize topography in the watershed. DEM data obtained from BASINS show that elevation in the watershed ranges from approximately 258 to 771 feet above mean sea level, with an average elevation of 489 feet above mean sea level.

2.1.4 Soils

The South Run watershed soil characterization was based on the NRCS State Soil Geographic (STATSGO) Database for Virginia. There are six general soil associations present in the South Run watershed; Catoctin-Myersville-Rock Outcrop, Braddock-Dyke, Buckhall-Occoquan-Meadowville, Penn-Croton-Calverton, Airmont-Stumptown-Weverton, and Jackland-Waxpool-Catlett. The majority of soils in the watershed are comprised of the Penn-Croton-Calverton, Catoctin-Myersville-Rock Outcrop, and Braddock-Dyke soils associations. The distribution of soils in the South Run watershed, along with the hydrologic soil groups of each of the soils associations, is presented in **Table 2-1**.

Table 2-1: Soil Types in the South Run Watershed

Map Unit ID	Soil Association	Percent	Hydrologic Soil Group
VA006	Catoctin-Myersville-Rock Outcrop	29.2	B/C
VA012	Braddock-Dyke	18.1	B
VA013	Buckhall-Occoquan-Meadowville	3.2	B
VA015	Penn-Croton-Calverton	38.5	B/C
VA021	Airmont-Stumptown-Weverton	1.9	B/C
VA022	Jackland-Waxpool-Catlett	9.1	B/C/D

Source: State Soil Geographic (STATSGO) Database for Virginia

Hydrologic soil groups represent the different levels of soil infiltration capacity. Hydrologic soil group "A" designates soils that are well to excessively well drained,

whereas hydrologic soil group "D" designates soils that are poorly drained. This means that soils in hydrologic group "A" allow a larger portion of the rainfall to infiltrate and become part of the groundwater system. On the other hand, compared to the soils in hydrologic group "A", soils in hydrologic group "D" allow a smaller portion of the rainfall to infiltrate and become part of the groundwater, resulting in more rainfall delivered to surface waters in the form of runoff. Descriptions of the hydrologic soil groups are presented in **Table 2-2**.

Table 2-2: Descriptions of Hydrologic Soil Groups

Hydrologic Soil Group	Description
A	High infiltration rates. Soils are deep, well drained to excessively drained sand and gravels.
B	Moderate infiltration rates. Deep and moderately deep, moderately well and well-drained soils with moderately coarse textures.
C	Moderate to slow infiltration rates. Soils with layers impeding downward movement of water or soils with moderately fine or fine textures.
D	Very slow infiltration rates. Soils are clayey, have high water table, or shallow to an impervious cover

2.1.5 Land Use

The land use characterization for the South Run watershed was based on land cover data from both the Northern Virginia Regional Commission (NVRC) 2000 Land Use Dataset, and the 1992 USGS National Land Cover Data (NLCD). The NVRC dataset was the most recent available land use dataset, and was also utilized in order to be consistent with other ongoing modeling efforts within the Occoquan River watershed. However, the NVRC dataset does not specify forested or open (i.e., pasture) lands; therefore, the NLCD dataset was used to fill in the remaining areas. The distribution of land uses in the South Run watershed, by land area and percentage, is presented in **Table 2-3**. Agricultural lands (34.3%), forested lands (32.9%) and developed lands (31.0%) represent the dominant land use types in the watershed. **Figure 2-2** displays a map of the land uses within the watershed.

Table 2-3: South Run Watershed Land Use Distribution

General Land Use Category	Specific Land Use Type	Acres	Percent of Watershed	Total Percent
Water/ Wetlands	Open Water	72.9	1.6	1.8
	Emergent Herbaceous Wetlands	5.4	0.1	
Developed	Low Intensity Residential	1249.2	27.9	31.0
	Medium/High Intensity Residential	2.6	0.1	
	Commercial/Industrial	126.9	2.8	
	Institutional	9.7	0.2	
Agriculture	Pasture/Hay/Livestock	1471.0	32.9	34.3
	Row Crop	62.8	1.4	
Forest	Deciduous Forest	921.2	20.6	32.9
	Evergreen Forest	122.0	2.7	
	Mixed Forest	431.5	9.6	
Total		**4,475**	**100**	**100**

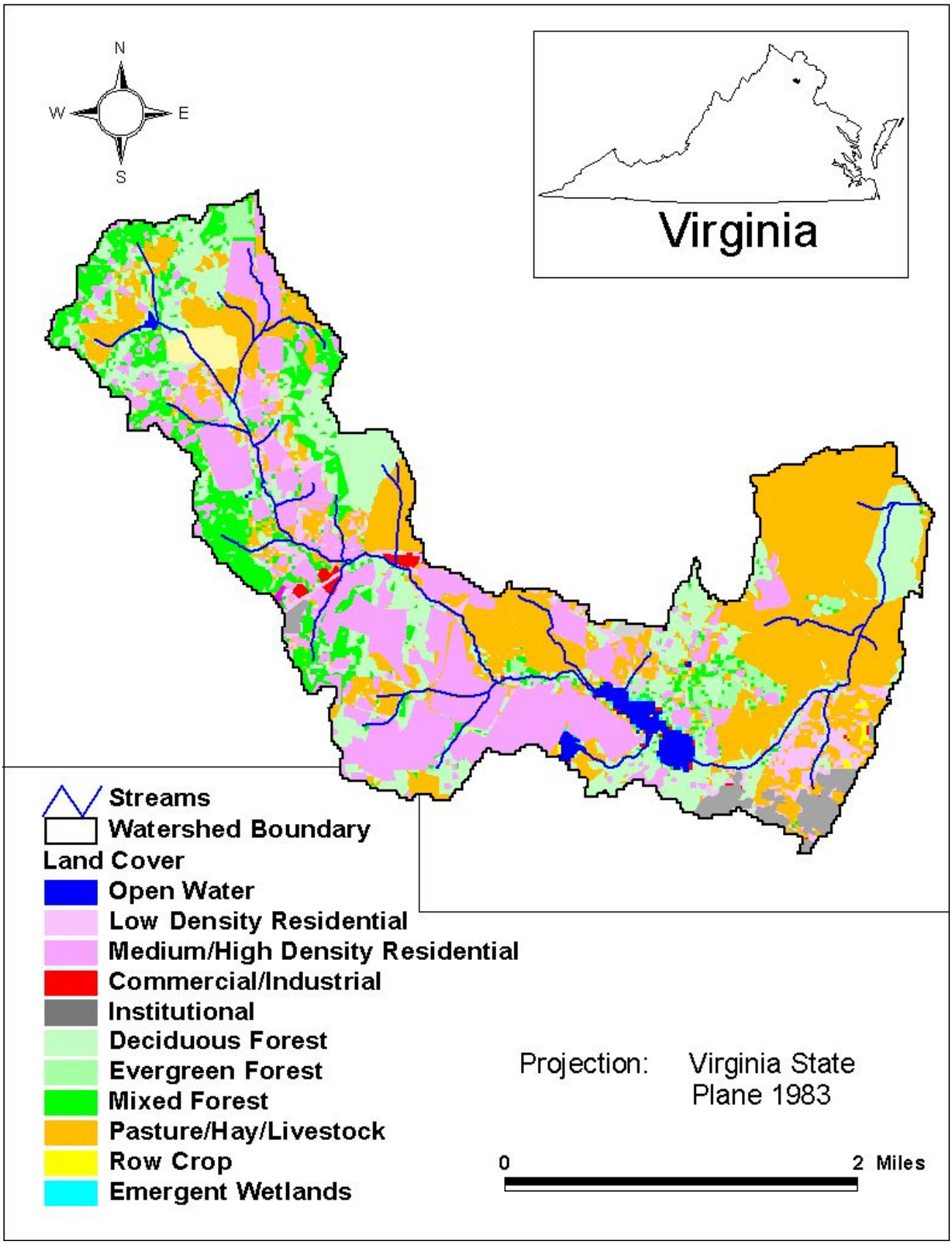

Figure 2-2: Land Use in the South Run Watershed

2.1.6 Ecoregion Classification

The South Run watershed is located in the Northern Piedmont ecoregion, USEPA Level III classification number 64 (Woods et al., 1999). The location of the South Run watershed within this ecoregion is presented in **Figure 2-3**. The Northern Piedmont ecoregion is a region of low rounded hills, irregular plains, and open valleys that serves as a transitional area between the low mountains to the north and west and the flat coastal plains to the east. Natural vegetation in the Northern Piedmont ecoregion is predominantly Appalachian oak forest, in contrast to the mostly oak-hickory-pine forests of the Piedmont ecoregion to the southwest.

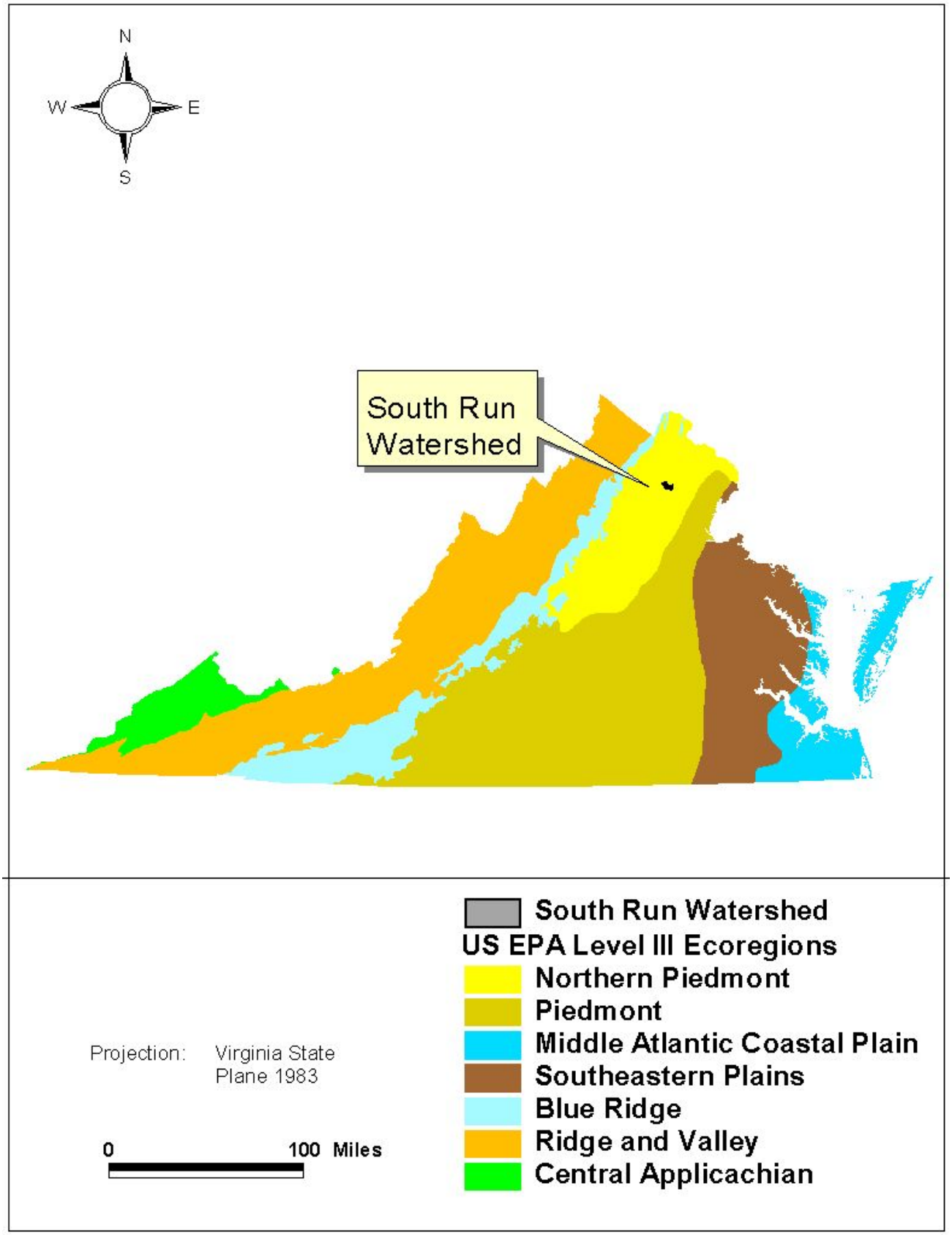

Figure 2-3: Virginia Level III Ecoregions

2.2 Permitted Discharge Facilities

There is one facility, the Vint Hill Farms Wastewater Treatment Plant (WWTP) which holds an active individual discharge permit in the South Run watershed. The permit number, type, permitted flow, receiving waterbody, and status of the Vint Hill facility is presented in **Table 2-4** and its location is presented in **Figure 2-4**. Based on information from DEQ, a total of 3 active general permits in the South Run watershed; 2 stormwater permits issued to construction sites, and 1 permit issued to a domestic sewage treatment facility. Additional information on recent MS4 and general construction permits is forthcoming from DCR. Additional information on the general permits is presented in **Table 2-5**.

Table 2-4: Individual Permitted Facility Discharging into the South Run Watershed

Permit Number	Facility Name	Facility Type	Design Flow (gpd)	Receiving Waterbody	Status
VA0020460	Vint Hill Farms WWTP	Municipal	-	South Run	Active

Table 2-5: General Permits Issued in the South Run Watershed

Permit Number	Facility Name	Permit Type	Design Flow (gpd)[1]	Receiving Waterbody	Status
VAR104944	Vint Hill -Landbay K, Lot 1	Stormwater Construction	-	South Run to Lake Manassas	Active
VAR101447	Vint Hill Farms Station	Stormwater Construction	-	South Run UT	Active
VAG406134	Residence	Domestic Sewage	500	South Run, UT	Active

Note: The information in this table is based on data from DEQ. Additional information on general permits is forthcoming from DCR.

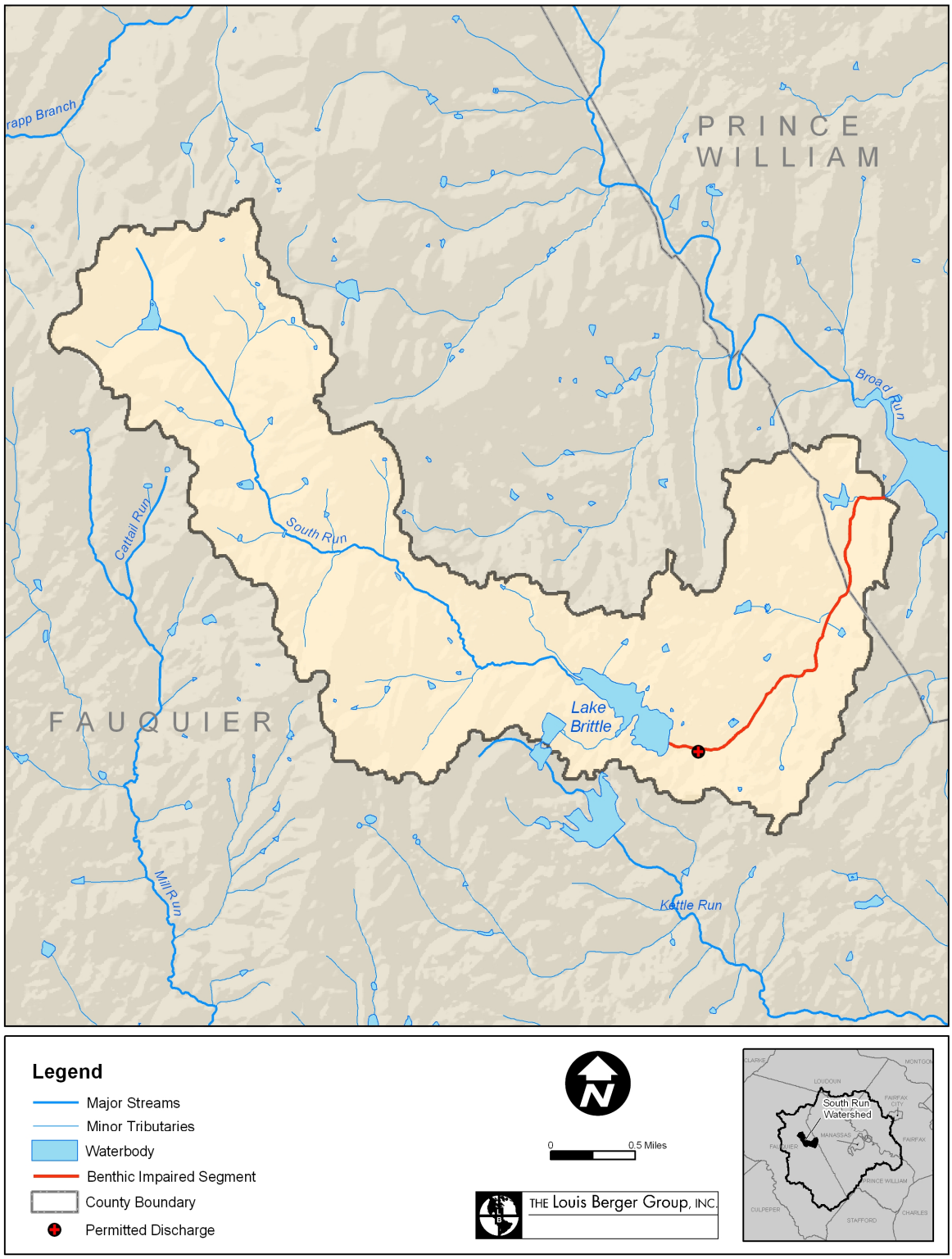

Figure 2-4: Location of Individual Permitted Facility Discharging into South Run

2.3 DEQ Monitoring Stations

DEQ has several monitoring stations on South Run which are used for biological and ambient water quality monitoring. A summary list of the DEQ monitoring stations located on South Run is presented in **Table 2-6**, and the locations of these stations are presented in **Figure 2-5**. Station identification numbers include the abbreviated creek name and the river mile on that creek where the station is located. The river mile number represents the distance from the mouth of the creek.

Monitoring station 1ASOT001.44 contained the longest ambient water quality data record; recent ambient monitoring data have also been collected at station 1ASOT001.65. Biological monitoring data were collected at station 1ASOT001.65; South Run was classified as impaired based on the results of bioassessment surveys conducted at this station. A detailed discussion of the available environmental monitoring data is presented in Section 3.0.

Table 2-6: Summary of Monitoring Stations on South Run

Station ID	Station Type	Period Of Record
1ASOT001.44	Ambient Water Quality	1978-2001
1ASOT001.65	Ambient and Biological	1994-2004
1ASOT002.46	Ambient Water Quality	1989-1990

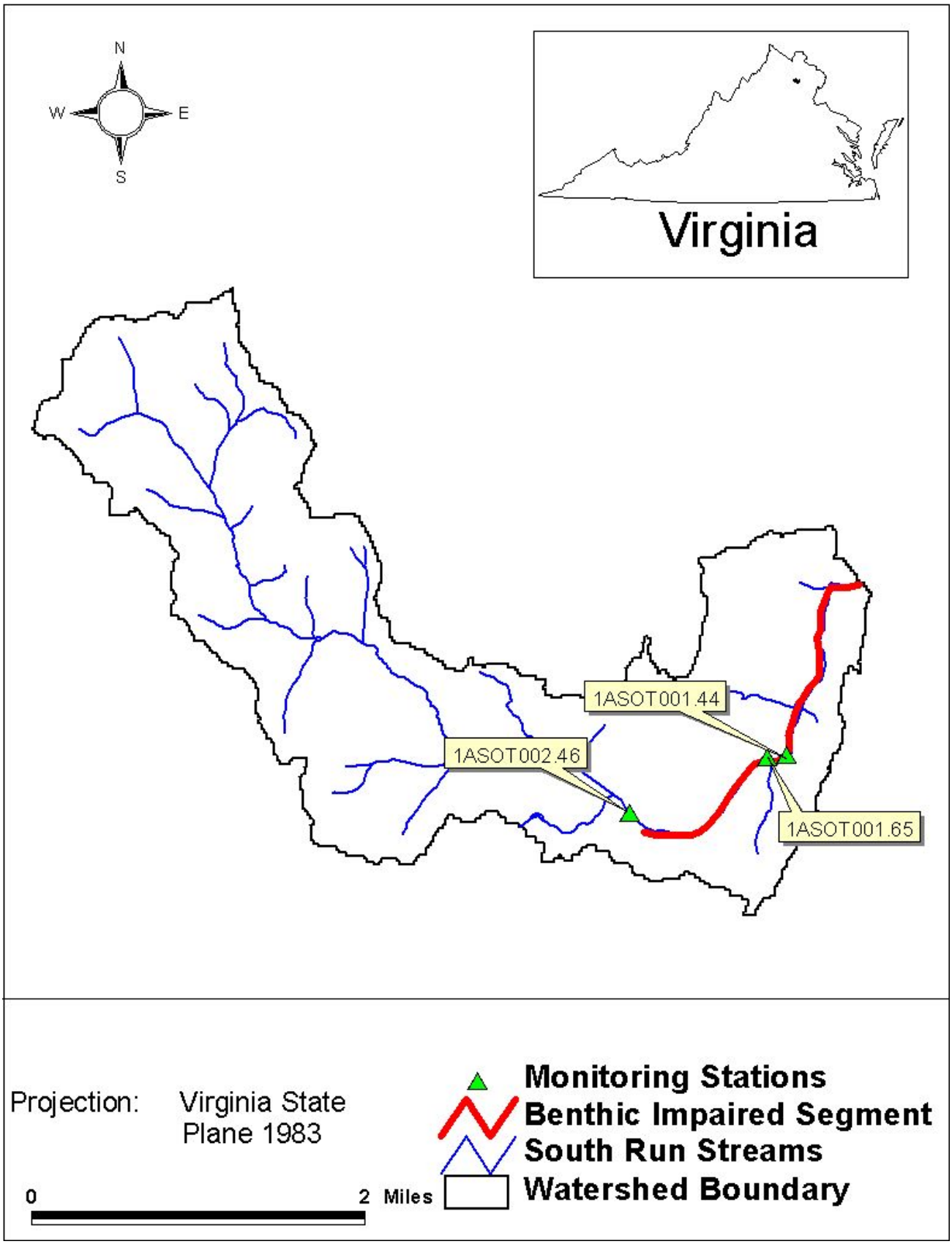

Figure 2-5: DEQ Monitoring Stations in the South Run Watershed

2.4 Overview of the South Run Watershed

Agricultural lands (34.3%), forested lands (32.9%) and developed lands (31.0%) represent the dominant land uses in the South Run watershed. There is 1 facility holding an active individual permit in the watershed, and 3 facilities holding active general permits in the watershed. Biological monitoring has been conducted by DEQ at station 1ASOT001.65 on the biologically impaired segment of South Run, and DEQ has collected ambient water quality data at three stations in the watershed. The land use and the locations of the facilities and monitoring stations in the watershed are shown in the summary map presented in **Figure 2-6**.

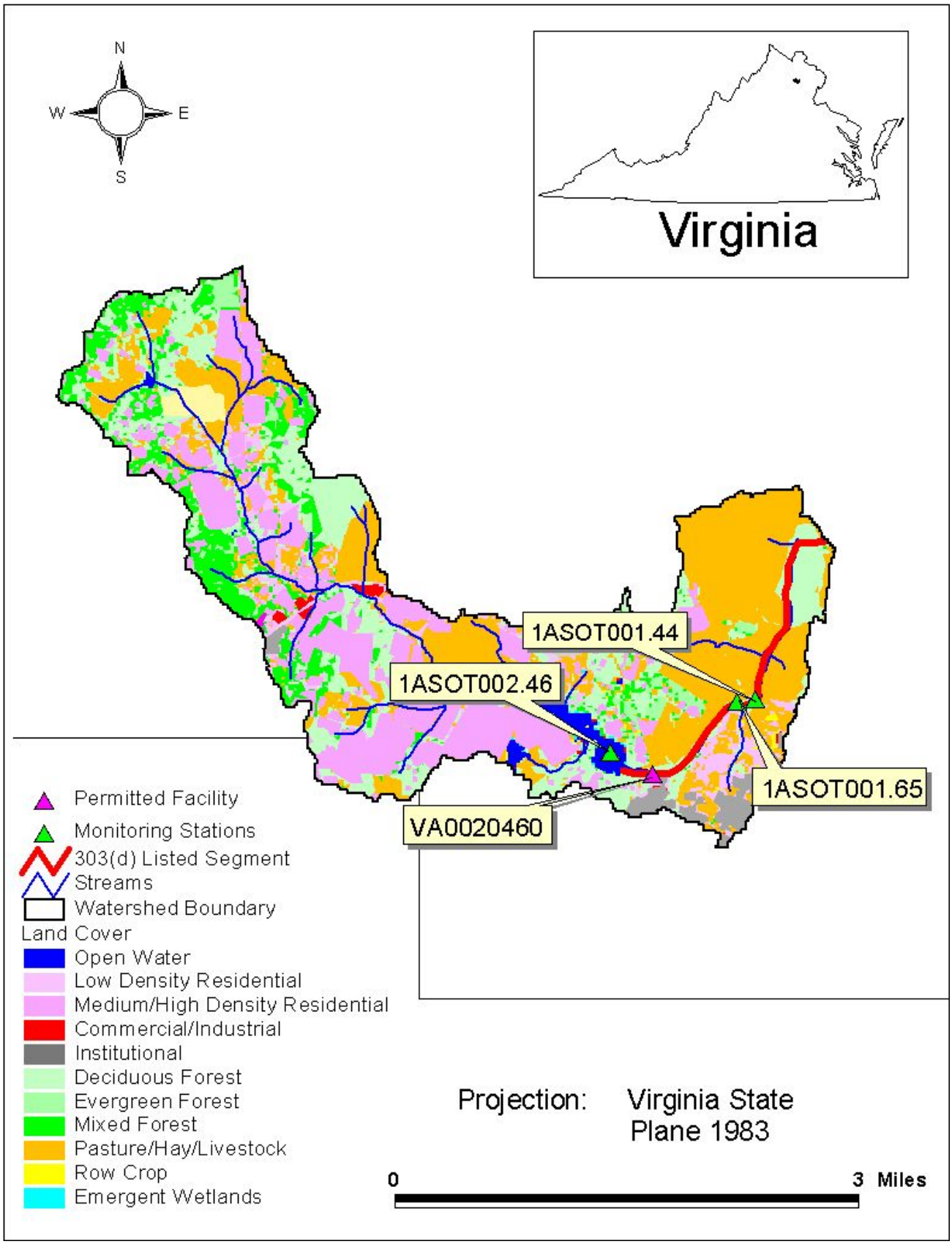

Figure 2-6: Overview of the South Run Watershed

3.0 Environmental Monitoring

Environmental monitoring efforts in the South Run watershed include benthic community sampling and analysis, habitat condition assessments, ambient water quality sampling, and toxicity testing. Monitoring efforts have been conducted by the Virginia Department of Environmental Quality (VADEQ) and the Occoquan Watershed Monitoring Lab (OWML). **Figure 3-1** plots the location of all monitoring locations in the South Run watershed used for this analysis.

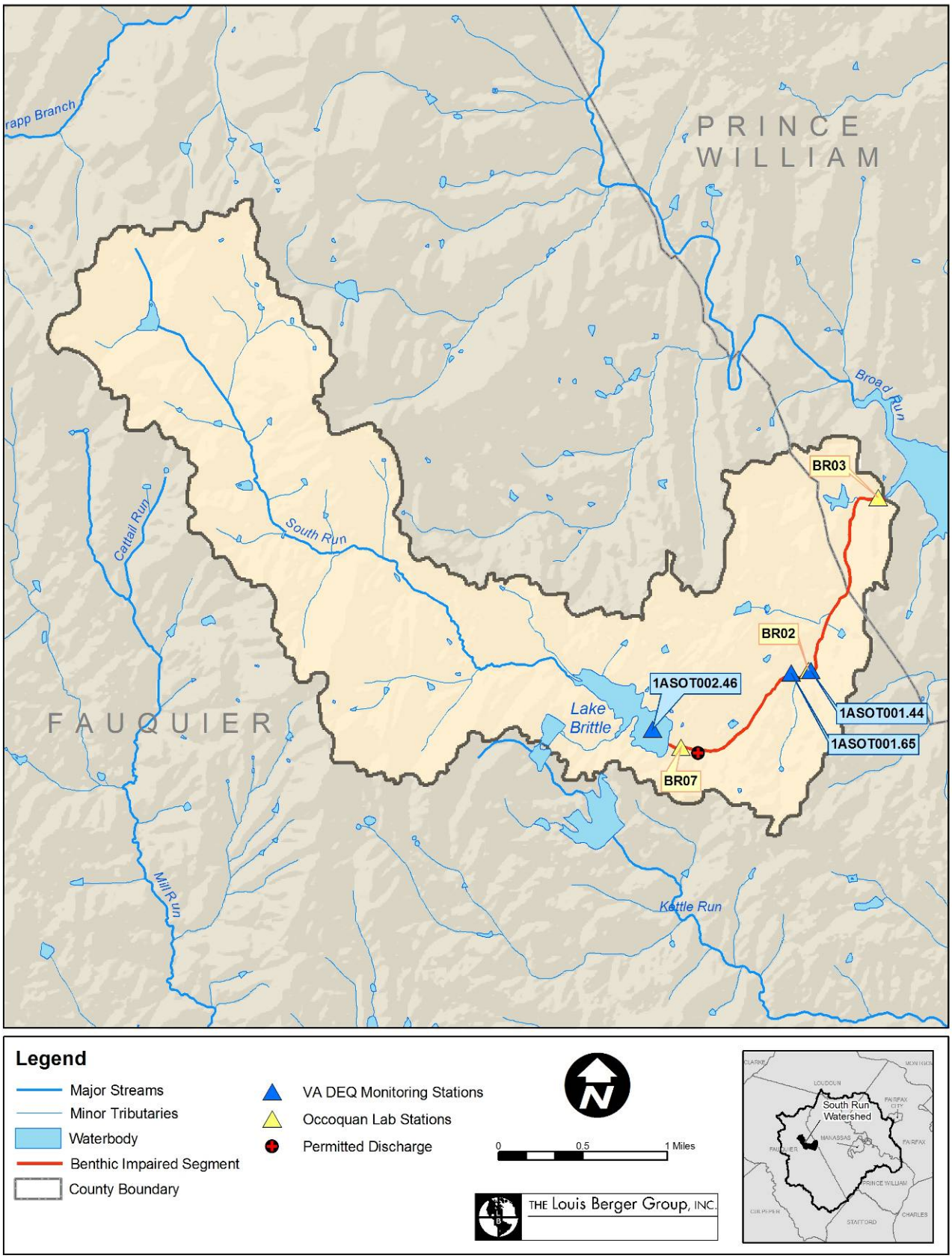

Table 3-1: Monitoring Locations in the South Run Watershed

3.1 Virginia Department of Environmental Quality Data

The first step in benthic TMDL development is the identification of the pollutant stressor(s) that is impacting the benthic community. Environmental monitoring data are vital to this initial step. The following sections summarize and present the available monitoring data used to determine the primary stressor impacting the biologically impaired segment of South Run. Analyzed data included available biological and water quality monitoring data, Discharge Monitoring Reports (DMR) from the permitted facility, and results from recent DEQ instream toxicity studies conducted on South Run. The collection period, content, and monitored sites for these data are summarized in **Table 3-1**. The locations of permitted discharge facility and monitoring stations are presented in **Figure 3-1**.

Table 3-1: Inventory of Environmental Monitoring Data for South Run

Data Type	Collection Period	Monitoring Stations			
		1ASOT001.44	1ASOT001.65	1ASOT002.46	Vint Hill Farms WWTP
DEQ Biological Monitoring	1994-2005		X		
DEQ Ambient Water Quality Monitoring	1978-2005	X	X	X	
DEQ Field Water Quality Monitoring	1994-2005		X		
DEQ Toxicity Study	April 2004, May 2005		X		
Discharge Monitoring Reports (DMR)	1999- 2005				X

3.1.1 Biological Monitoring Data

The impaired segment of South Run was included on Virginia's 1998 Section 303(d) List of Impaired Waters and was subsequently included on Virginia's 2002 Section 303(d) List of Impaired Waters and in the 2004 Water Quality Assessment 305(b)/303(d) Integrated Report based on biomonitoring results obtained between 1994 and 2004.

RBPII

A modified version of the EPA Rapid Bioassessment Protocols II (RBPII) was used to assess the biological condition of the stream's benthic invertebrate communities. Candidate RBPII metrics, as specified in EPA's Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers, Second Edition (Barbour et al., 1999), are presented in **Table 3-2**. RBPII assessment ratings for the biomonitoring surveys conducted on South Run are presented in **Table 3-3**.

Virginia DEQ bioassessments follow a paired reference approach using upstream stations located in the same watershed. The DEQ protocol uses eight standard metrics to compare monitored and reference sites. These metrics include taxa richness, composition, and tolerance/intolerance measures (**Table 3-2**).

DEQ field data sheets and bioassessment forms completed for each biological assessment conducted on South Run contained the following information:

- Assessment ratings for each station for each survey event
- The numbers and types of macroinvertebrates present at each station
- Habitat assessment scores taken during each survey
- Field water quality data collected as part of each survey

Table 3-2: Candidate RBPII Metrics Specified in Barbour et al. (2002)

Category	Metric	Definition	Expected Response to Disturbance
Richness Measures	Total No. Taxa	Measures overall variety of invertebrate assemblage	Decrease
	No. EPT Taxa	Number of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease
	No. Ephemeroptera Taxa	Number of mayfly taxa	Decrease
	No. Plecoptera Taxa	Number of stonefly taxa	Decrease
	No. Trichoptera Taxa	Number of caddisfly taxa	Decrease
Composition Measures	% EPT	Percent of the composite of mayfly, stonefly, and caddisfly larvae	Decrease
	% Ephemeroptera	Percent of mayfly nymphs	Decrease
Tolerance/ Intolerance Measures	No. Intolerant Taxa	Taxa richness of organisms considered to be sensitive to perturbation	Decrease
	% Tolerant Organisms	Percent of the macrobenthos considered to be tolerant of various types of perturbation	Increase
	% Dominant Taxon	Measures dominance of the most abundant taxon. Can be calculated as dominant 2, 3, 4, or 5 taxa	Increase
Feeding Measures	% Filterers	Percent of the macrobenthos that filter FPOM from water column or sediment	Variable
	% Grazers and Scrapers	Percent of macrobenthos that scrape or graze upon periphyton	Decrease
Other Measures	Hilsenhoff Biotic Index	Uses tolerance values to weight abundance in an estimate of overall pollution	Increase

Table 3-3: RBPII Assessment Ratings for South Run Biomonitoring Surveys

Station	Time Period	Assessment Rating
1ASOT001.65	Spring 1994	Moderate Impairment
	Fall 1994	Moderate Impairment
	Spring 1995	Moderate Impairment
	Fall 1995	Moderate Impairment
	Spring 1996	Moderate Impairment
	Fall 1996	Moderate Impairment
	Spring 1997	Moderate Impairment
	Fall 1997	Moderate Impairment
	Spring 1998	Moderate Impairment
	Spring 1999	Slight Impairment
	Fall 1999	Slight Impairment
	Spring 2000	Slight Impairment
	Fall 2000	Moderate Impairment
	Spring 2004	Slight Impairment
	Fall 2004	Slight Impairment
	Spring 2005	Moderate Impairment

Biomonitoring surveys were conducted biannually at 1ASOT001.65 from 1994 to 2000 and again from 2004 to 2005. Out of the 16 samples taken at this station, 11 were rated as moderately impaired and 5 were rated as slightly impaired. Three RBPII metrics consistently showed scores that were lower than those observed at the reference site. The first two, EPT to Chrionomidae abundance ratios (which compares the total number of mayflies, stoneflies, and most caddisflies which are mostly sensitive to pollution, to the number of midges a predominantly tolerant family) and the EPT index (the total number of distinct taxa within the EPT groups) estimate the relative abundance of sensitive species present in the community and are therefore general indicators of water quality conditions. Scores for the third metric, the MFBI (Modified Family Biotic Index), were frequently observed above 4.5, which may indicate organic pollution is affecting the benthic community.

SCI Scores

Using the data collected during biomonitoring surveys, biological assessment scores were calculated using the Virginia Stream Condition Index (SCI) currently being developed by DEQ. The SCI is a regionally-calibrated index comprised of eight metrics that are listed in **Table 3-4**. The metrics used in calculation of an SCI score are similar to the metrics used in RBPII assessments. However, unlike RBPII, the reference condition of the SCI is based on an aggregate of reference sites within the region, rather than a single paired reference site. Therefore, SCI scores provide a measure of stream biological integrity on a regional basis. An impairment cutoff score of 61.3 has been proposed for assessing results obtained with the SCI. Streams that score greater than 61.3 are considered to be non-impaired, whereas streams that score less than 61.3 are considered impaired.

Calculated SCI scores for the biomonitoring station 1ASOT001.65, located on South Run, are presented in **Table 3-5**. SCI scores calculated for station 1ASOT001.65 were, on average, below the proposed impairment cutoff score of 61.3; therefore, the station is considered to be impaired. Station 1ACAX004.57, located on Catoctin Creek, served as the reference station for the South Run biological assessment from 1994 to 2000. However, this monitoring station was discontinued as a reference site after 2000 due to a decline in the observed benthic community at this location. Station 1AGOO022.44, located on Goose Creek, served as the reference station for the biological assessments conducted on South Run in 2004. Both of the reference stations had average SCI scores above the proposed impairment cutoff score.

Table 3-4: Metrics Used to Calculate the Virginia Stream Condition Index (SCI)

Candidate Metrics (by categories)	Expected Response to Disturbance	Definition of Metric
Taxonomic Richness		
Total Taxa	Decrease	Total number of taxa observed
EPT Taxa	Decrease	Total number of pollution sensitive Ephemoroptera, Plecoptera, and Trichoptera taxa observed
Taxonomic Composition		
% EPT Less Hydropsychidae	Decrease	% EPT taxa in samples, subtracting pollution-tolerant Hydropsychidae
% Ephemoroptera	Decrease	% Ephemoroptera taxa present in sample
% Chironomidae	Increase	% pollution-tolerant Chironomidae present
Balance/Diversity		
% Top 2 Dominant	Increase	% dominance of the 2 most abundant taxa
Tolerance		
HBI (Family level)	Increase	Hilsenhoff Biotic Index
Trophic		
% Scrapers	Decrease	% of scraper functional feeding group

Table 3-5: Virginia SCI Scores for South Run

Collection Period	SCI Score		
	1ASOT001.65	1ACAX004.57[1]	1AGOO022.44[2]
Spring 1994	Not available	-	-
Fall 1994	47.8	69.6	-
Spring 1995	56.8	72.4	-
Fall 1995	58.5	65.1	-
Spring 1996	40.5	66.4	-
Fall 1996	56.8	62.4	-
Spring 1997	60.2	69.7	-
Fall 1997	61.9	74.8	-
Spring 1998	65.7	73.6	-
Fall 1998	63.6	68.7	-
Spring 1999	58.5	72.5	-
Fall 1999	60.6	70.5	-
Spring 2000	63.7	70.5	-
Fall 2000	58.7	68.0	-
Spring 2004	44.4	-	67.6
Fall 2004	62.7	-	62.6
Spring 2005	42.2		
Average	**56.4**	**69.5**	**65.1**

1: Monitoring station 1ACAX004.57 served as the reference station from 1994-2000
2: Monitoring station 1AGOO022.44 served as the reference station for 2004

3.1.2 Habitat Assessment Scores

A suite of habitat variables were visually inspected at station 1ASOT001.65 as part of the biological assessments conducted on South Run. Habitat parameters that were examined include channel alteration, sediment deposition, substrate embeddedness, riffle frequency, channel flow and velocity, stream bank stability and vegetation, and riparian zone vegetation. Each parameter was assigned a score from 0 to 20, with 20 indicating optimal conditions, and 0 indicating very poor conditions. Habitat assessment scores for the South Run biomonitoring station, as well as the reference stations, are presented in **Table 3-6**.

Overall habitat assessment scores were similar between impaired station 1ASOT001.65 and the reference stations. Individual habitat parameters were also generally similar between the impaired and reference stations, with the exception of the channel flow and velocity regime parameters, for which the reference stations on average scored higher than the impaired station.

Table 3-6: Habitat Scores for Reference and Impaired Stations

Station ID	Date	Total Habitat Score	Channel Alteration	Bank Stability	Bank Vegetative Protection	Substrate Embeddedness	Channel Flow	Riffles	Riparian Zone	Sediment Deposition	Velocity Regime
1ASOT001.65	Fall 1994	160	16	17	18	17	14	18	15	16	12
	Spring 1995	176	18	19	19	17	17	18	20	16	14
	Fall 1995	167	19	18	20	18	9	18	18	18	11
	Spring 1996	174	18	19	19	18	15	18	18	17	16
	Fall 1996	183	19	20	20	17	18	18	18	18	17
	Spring 1997	181	18	19	19	18	17	19	18	18	17
	Fall 1997	178	19	20	20	18	15	18	18	17	15
	Fall 1998	175	17	19	20	18	16	18	18	17	14
	Spring 1998	154	18	19	19	18	8	11	18	17	9
	Fall 1999	170	18	18	18	17	16	18	18	16	15
	Spring 1999	183	19	20	20	18	18	19	19	18	16
	Fall 2000	178	20	18	18	17	19	19	16	17	18
	Spring 2000	169	17	20	20	16	14	18	18	17	12
	Fall 2004	185	20	20	20	17	19	19	19	18	15
	Spring 2005	161	20	18	18	15	14	19	17	14	13
	AVG.	**172.9**	**18.4**	**18.9**	**19.2**	**17.3**	**15.3**	**17.9**	**17.9**	**16.9**	**14.3**
1ACAX004.57	Fall 1994	168	18	16	16	18	17	16	16	16	17
	Spring 1995	179	19	18	18	17	18	18	19	17	17
	Fall 1995	180	19	19	19	17	18	18	17	17	18
	Spring 1996	184	19	19	18	18	19	19	18	18	18
	Fall 1996	178	18	18	19	18	18	17	19	16	17
	Spring 1997	180	19	17	17	18	19	18	17	18	19
	Fall 1997	177	19	18	18	17	18	17	17	17	17
	Fall 1998	170	17	17	17	16	18	17	17	16	18
	Spring 1999	176	18	17	18	19	18	17	17	18	16
	Fall 1999	179	18	18	18	18	19	18	17	17	18
	Spring 2000	163	18	17	17	14	19	17	16	10	18
	Fall 2000	164	18	15	17	15	19	16	15	14	18
	Fall 2004	165	18	14	16	17	18	17	16	16	16
	AVG.	**174.1**	**18.3**	**17.2**	**17.5**	**17.1**	**18.3**	**17.3**	**17.0**	**16.2**	**17.5**
1AGOO022.44	Spring 2004	174	19	17	19	16	18	16	19	16	17
	Fall 2004	176	20	18	18	16	18	16	19	15	19
	AVG.	**19.5**	**17.5**	**18.5**	**16.0**	**18.0**	**16.0**	**19.0**	**15.5**	**18.0**	**19.5**

3.1.3 Water Quality Monitoring

There are three DEQ ambient water quality monitoring stations located in the South Run watershed. Information on each ambient monitoring station is summarized in **Table 3-7**. Monitoring station 1ASOT001.44 represents the largest sources of water quality data available in the watershed.

Table 3-7: Ambient Water Quality Monitoring Stations Located on South Run

Station Id	Station Location	Period of Record	River Mile	No. Sampling events
1ASOT001.44	Intersection with Route 215	1978-2001	1.44	214
1ASOT001.65	Intersection with Route 652	2003-2005	1.65	17
1ASOT002.46	Off Route 793, near Vint Hill	1989-1990	2.46	12

3.1.4 Instream Water Quality Data

Instream water quality data collected on South Run from 1990 to 2005 are presented in **Figures 3-2** to **3-12**. South Run is classified as a Class III waterbody (Nontidal Waters), as defined in Virginia Water Quality Standards (9 VAC 25-260-50). Thus, water quality parameters in the impaired segment must meet the Class III standards (**Table 3-8**).

Table 3-8: Virginia Water Quality Standards for South Run

Class	Description of Waters	Dissolved Oxygen (mg/L)		pH	Maximum Temperature (Deg. C)
		Minimum	Daily Average		
III	Nontidal Waters	4.0	5.0	6.0-9.0	32

Instream water quality data collected on South Run at stations 1ASOT001.65 and 1ASOT001.44 are presented in **Figures 3-2** to **3-12**. The following is a bulleted summary of the monitoring data:

- Field dissolved oxygen and temperature values have been in compliance with numeric criteria for Class III waters (**Figures 3-2** and **3-4**).

- South Run pH values were also within the acceptable range for the majority of the period of record (**Figure 3-6**). However, at Station 1SOT001.44 a few exceedences of the minimum standard were recorded, and at Station 1SOT001.65 one exceedence of the maximum standard was recorded.

- Biochemical oxygen demand concentrations at the station were low (**Figure 3-7**).

- Total suspended solids concentrations were generally low, but were elevated during some sampling events (**Figure 3-8**).

- Nitrate concentrations were elevated in the early 1990's, but have been consistently below 2 mg/L since the mid 1990's (**Figure 3-9**).

- Ammonia and total phosphorus concentrations were generally low across monitoring stations and sampling events (**Figures 3-10** and **3-11**).

- Several violations of the Virginia fecal coliform instantaneous standard occurred at monitoring station 1ASOT001.44 (**Figure 3-12**); a bacteria TMDL is currently being developed for South Run and will be presented in a separate report.

Note: Date ranges in the following graphs are intentionally held constant for all graphs (excluding diurnal DO) to allow for vertical comparison between measured parameters. In those instances where no data is shown for a particular time period, no measurements of the parameter were taken allowing for visual identification of temporal data gaps.

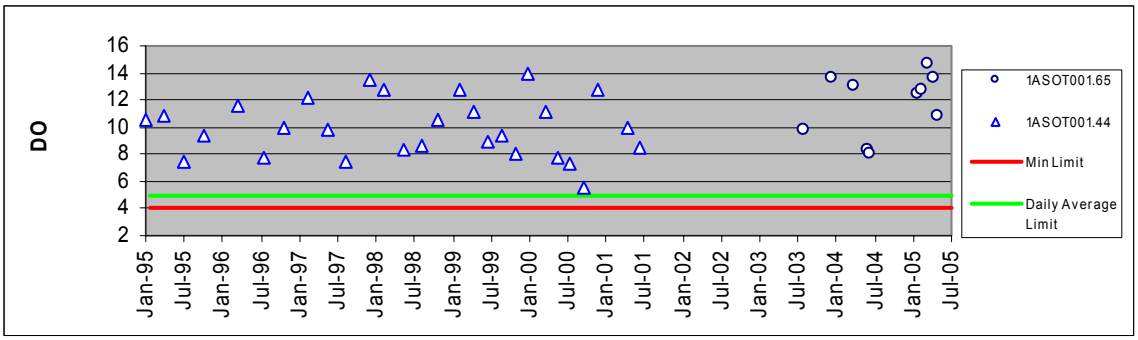

Figure 3-2: South Run Field Dissolved Oxygen Concentrations

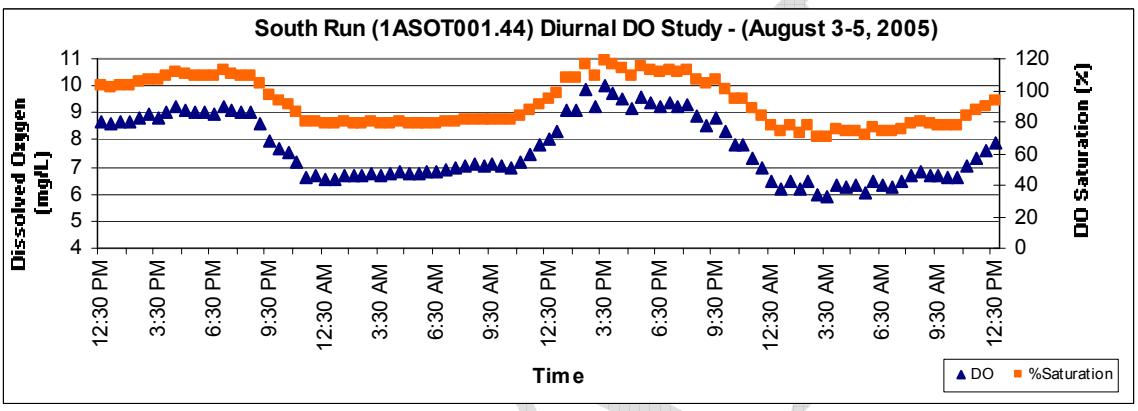

Figure 3-3: South Run Diurnal DO Concentrations

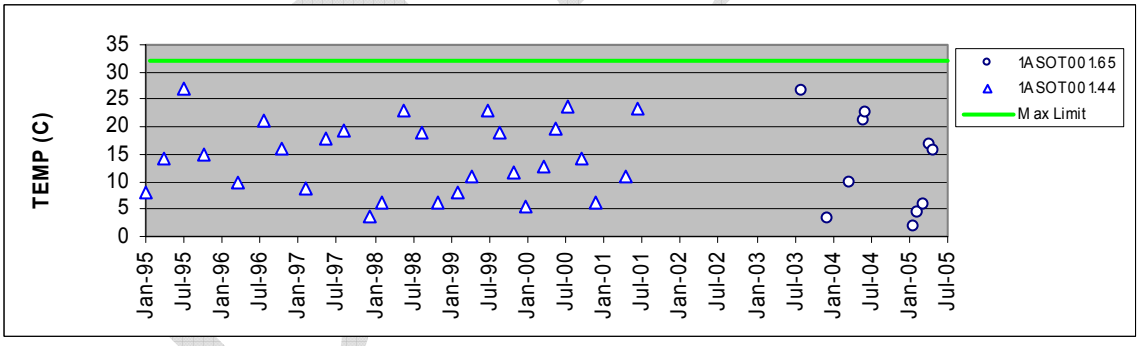

Figure 3-4: South Run Field Temperature Data

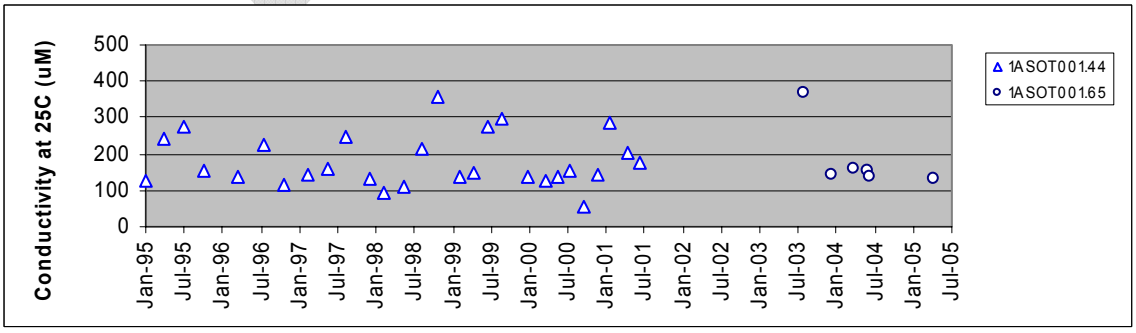

Figure 3-5: South Run Conductivity Data

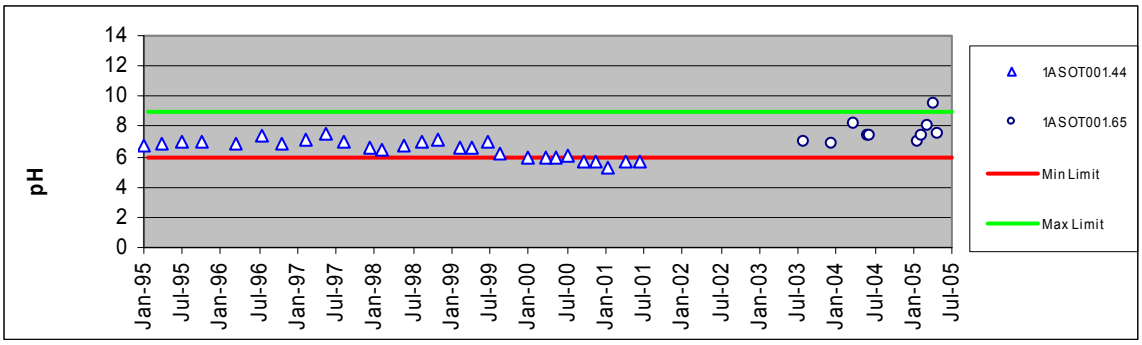

Figure 3-6: South Run pH Data

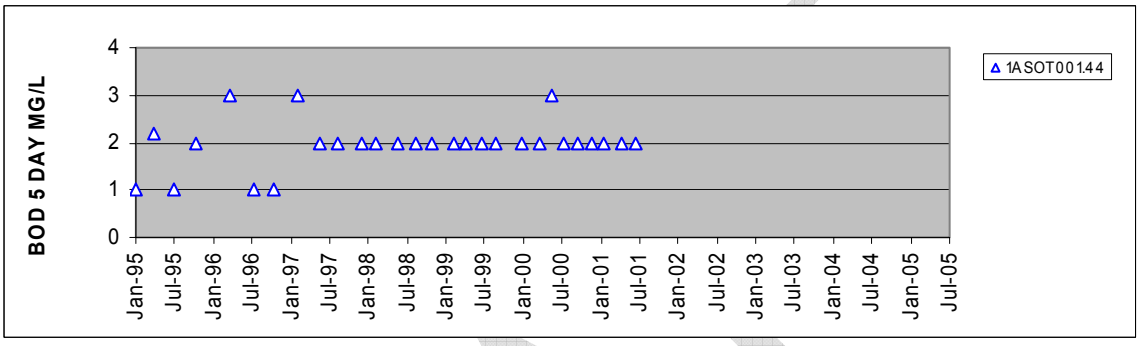

Figure 3-7: South Run Biochemical Oxygen Demand Concentrations

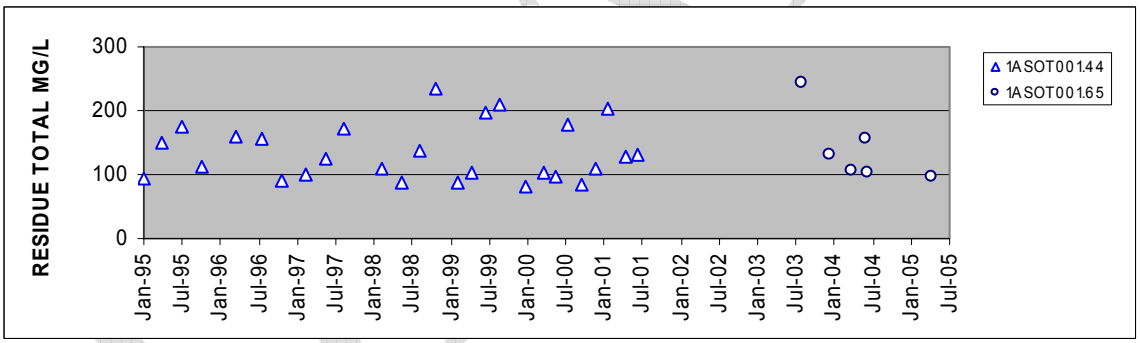

Figure 3-8: South Run Total Suspended Solids Concentrations

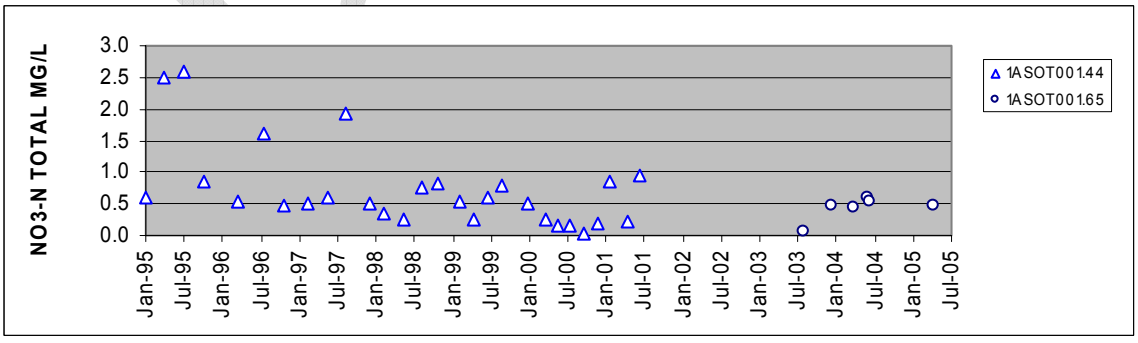

Figure 3-9: South Run Nitrate Concentrations

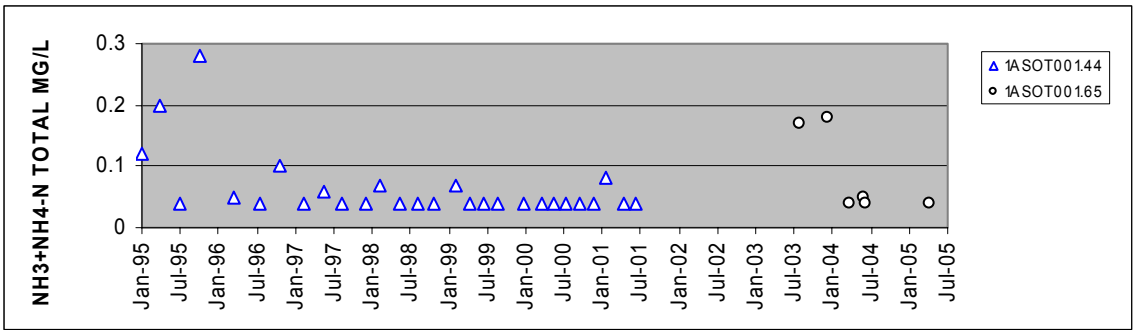

Figure 3-10: South Run Ammonia Concentrations

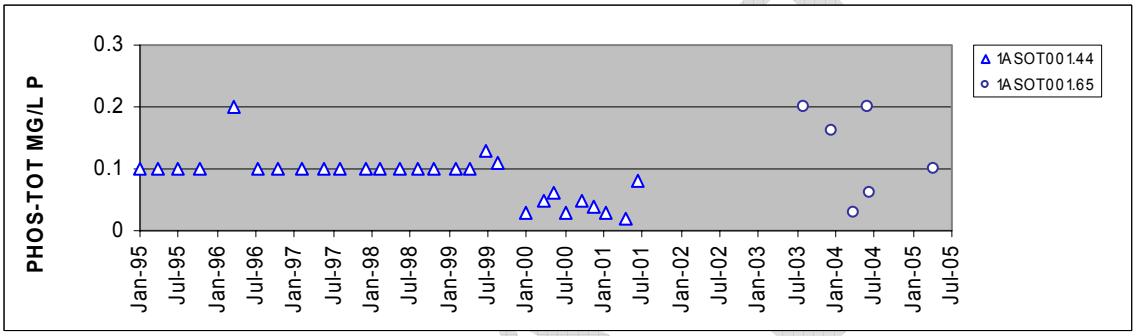

Figure 3-11: South Run Total Phosphorus Concentrations

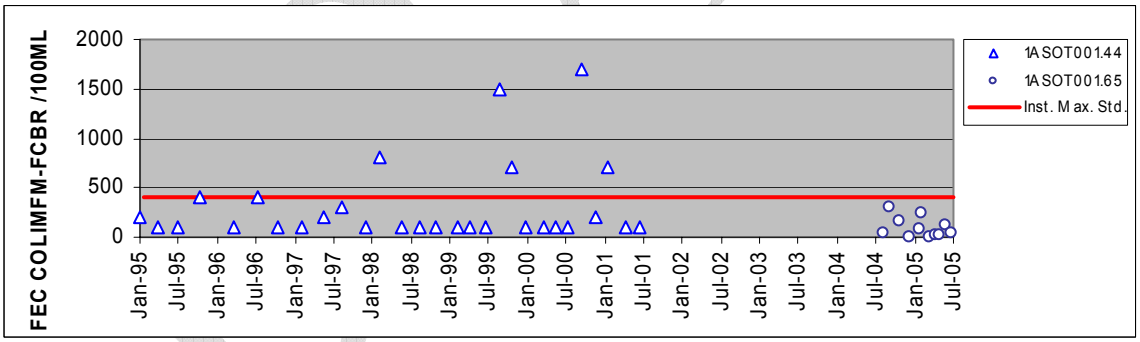

Figure 3-12: South Run Fecal Coliform Concentrations

3.1.5 Metals Data

Both dissolved and sediment metals parameters were examined in South Run, including arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. All available dissolved metals data collected in South Run were analyzed to determine whether the examined parameters complied with Virginia's established water quality standards. No monitored metals parameters violated acute or chronic dissolved

freshwater criteria specified in Virginia's water quality standards. Additionally, although there are currently no water quality standards established for sediment metals, the 2004 DEQ assessment guidance memorandum (DEQ, 2004) establishes consensus based sediment screening values for use in determining aquatic life use support. The sediment metals data collected on South Run were analyzed to determine whether they complied with the consensus based screening values. The consensus based Probable Effects Concentration (PEC) sediment screening value for silver (2.6 ppm, dry weight, 99th percentile of results throughout Virginia) was exceeded at 1ASOT001.44 in July 1995 and April 1999 and at 1ASOT001.65 in March 2004. As stated by the VA DEQ 303(d) fact sheet, *"As a result, the Aquatic Life Use goal is noted with an observed effect*" (VADEQ 2004).

Fish sampling was conducted in 2001 and 2004 and analyzed for metals. Results from fish tissue data collected in August 2001 at station 1ASOT001.44 revealed an exceedance of the risk-based Tissue Screening Value (TSI) of 0.072 parts per million (ppm) for arsenic. As stated by the VA DEQ 303(d) fact sheet in reference to this exceedence, "*As a result, the Fish Consumption Use goal was assessed as fully supporting with an observed effect*" (VA DEQ 2004). However, results from fish tissue sampled in July 2004 did not show any metals exceedances.

Organics data collected on South Run include dissolved and sediment samples analyzed for chlordane, dieldrin, endosulfan, endrin, heptachlor epoxide, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), and PCBs. All available organics data collected on South Run were analyzed to determine whether the examined parameters complied with Virginia's established water quality standards and sediment screening values. Organics concentrations were below detection limits for the majority of the samples analyzed. No monitored organics parameters violated acute or chronic dissolved freshwater criteria specified in Virginia's water quality standards. Additionally, none of the available sediment organics data violated the sediment screening values specified in the DEQ assessment guidance memorandum (DEQ, 2004). Fish tissue sampling

conducted in 2001 and 2004 also tested for organics. Results from these tests did not show any exceedences of the risk-based Tissue Screening Value for organic chemicals.

3.1.6 Toxicity Testing

Toxicity testing was performed on water samples collected on South Run by DEQ on April 12th, 14th, and 16th, 2004 and on May 2, 2005 at station 1ASOT001.65. The EPA Region 3 laboratory in Wheeling, West Virginia performed chronic toxicity testing on samples using fathead minnows and *Ceriodaphnia dubia* as test organisms. Results for samples analyzed in April 2004 indicated *Ceriodaphnia* mortality and reproduction in the South Run water samples were not statistically different than mortality and reproduction in the control samples, thus indicating that there were no toxic water column effects to *Ceriodaphnia* in the South Run samples. In 2004, fathead minnow growth in the South Run water samples was also not statistically different from growth in the control samples. However, fathead minnow survival in samples collected at station 1ASOT001.65 did significantly vary from minnow survival in the control samples. Minnow survival in samples collected at station 1ASOT001.65 was 50%, which was statistically different from the laboratory control and indicated the potential for toxicity in the South Run water samples collected in 2004.

Toxicity results for samples taken in May 2005 indicated that there were there were no toxic water column effects to *Ceriodaphnia* in the South Run water samples. However, fathead minnow survival in samples collected at station 1ASOT001.65 did significantly vary from minnow survival in the control samples. In addition, test samples also significantly affected the biomass of the fathead minnows.

In addition to being statistically different from the laboratory control, the effects observed in both 2004 and 2005 were probably biologically significant. However, these observed effects should be correlated with other available water quality parameters to determine the presence of toxicity (EPA, 2004; EPA, 2005).

3.2 Supplemental Monitoring Data

3.2.1 Occoquan Watershed Monitoring Lab

The Occoquan Watershed Monitoring Laboratory (OWML) has conducted water quality monitoring efforts throughout the Occoquan River Basin since its establishment in 1972 by the Virginia Polytechnic Institute Department of Civil Engineering. **Table 3-9** lists the OWML stations found in the watershed, the type of monitoring conducted, the period of record, and the number of sampling events conducted.

Table 3-9: Inventory of South Run Occoquan Monitoring Lab Data

Site ID	Station Location	Data Type	Sampling Period	Number of Sampling Events
BR02	South Run	Ambient	January 1994- December 2004	296
		Organics	January 1994-October 2004	43
BR03	South Run	Ambient	January 1994- December 2004	295
		Organics	January 1994-October 2004	43
BR07	South Run (immediately below dam)	Ambient	January 1994- December 2004	296
		Organics	January 1994-October 2004	42

Ambient water quality measurements at stations BRO2, BRO3, and BRO7 show results generally comparable to those reported in the VA DEQ data. Temperature and pH have been in compliance with Virginia's numeric criteria for Class III waters throughout the sample record. In general, total phosphorus and nitrogen were low across all sample stations (total phosphorus Max: 0.43, Min: 0.01, Avg. 0.06; total nitrogen Max: 2.45, Min: 0.66, Avg. 1.17). However, total nitrogen data from these three sampling stations in the watershed did show spatial variability. This variation is largely the result of nitrate, which comprises on average, 69% (BRO2), 42% (BRO3), and 26% (BRO7) of the total nitrogen samples. Nitrate concentrations were observed to be significantly different between station BRO7 and stations BRO2 and BRO3 ($P < 0.05$; 0.22 ± 0.13. 1.08 ± 1.48, and 0.42 ± 0.51).

The Occoquan Watershed Monitoring Laboratory (OWML) collected dissolved organic samples quarterly between 1994 and 2004 at stations BR02, BR03, and BR07 located on

South Run. Dissolved organics samples collected were analyzed for total of 53 parameters including acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluroanthene, benzylbutyl phthalate, beta-benzene hexachloride, chrysene, biben(a,h)anthracene, dieldrin, diethyl phthalate, dimethyl phthalate, dicotyl phthalate, fluoranthene, fluorene, hexachlororbenzene, heptachlor, malathion, napthalene, and simazine. Dissolved organics concentrations were below detection limits for the majority of the samples analyzed. All available organics data collected on South Run were analyzed to determine whether the examined parameters complied with Virginia's water quality standards. Twenty of the 53 organics parameters tested by OWML currently do not have limits listed in Virginia Water Quality Standards. No monitored dissolved organics parameters exceeded Virginia Sate acute or chronic dissolved freshwater criteria. However, on January 1, 1996 samples analyzed for benzo(a)pyrene collected at BR02, BR03, and BR07 did exceed Virginia's human health standards for all surface waters other than those used for public water supply.

3.3 Discharge Monitoring Reports

As stated in Section 2.2, there is one facility, the Vint Hill Farms WWTP, holding an active individual permit in the South Run watershed (**Table 2-4**). Upon future expansion of Vint Hill Farms, the current outfall location for the facility will be moved from South Run to Kettle Run as the receiving stream. DMR data for the Vint Hill facility are presented in **Figures 3-13** to **3-21**.

Flow data for the Vint Hill facility are presented in Figure 3-11. Dissolved oxygen concentrations have been in compliance with permitted effluent limits (**Figure 3-14**). Biological oxygen demand concentrations are generally low for the period of record, but appear to fluctuate more widely over the past two years (**Figure 3-15**). Several recent exceedances of the biological oxygen demand permitted limit were observed in the DMR data. pH values were within the acceptable range for the period of record (**Figure 3-16**), and total suspended solids concentrations were generally low in the Vint Hill WWTP effluent (**Figure 3-17**). Nutrient effluent concentrations were elevated, and on several occasions exceeded the permitted limits established for ammonia and total phosphorus

(**Figures 3-18** and **3-20**). Elevated nitrate as nitrogen levels were recorded and these levels exceeded the future effective nitrate as nitrogen limits. This limit becomes effective on October 1, 2007 and the permit includes a four-year compliance schedule for achieving compliance with final effluent limits **(Figure 3-19).** All observed fecal coliform bacteria concentrations were below permitted limits (**Figure 3-21**).

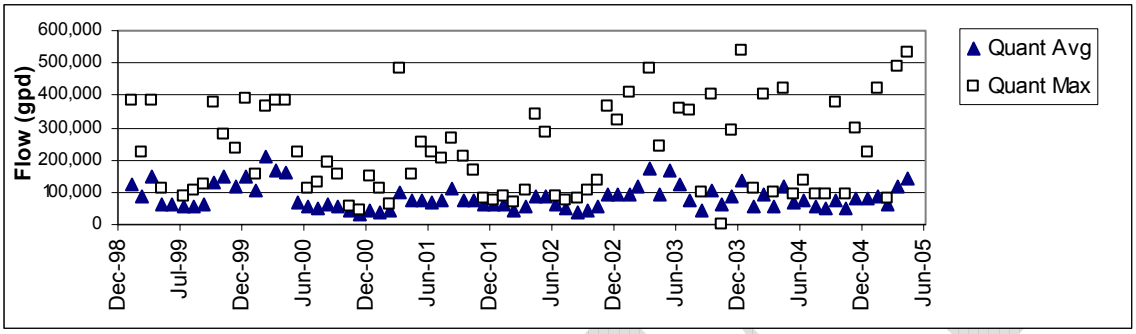

Figure 3-13: Vint Hill Effluent Flow Values

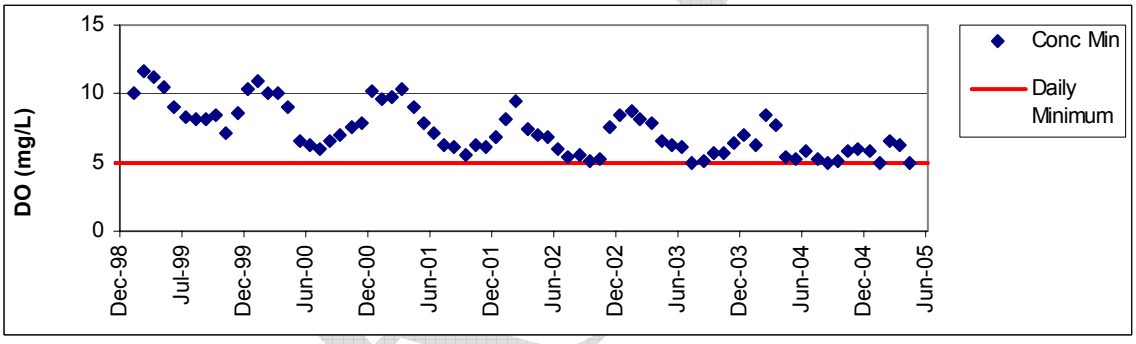

Figure 3-14: Vint Hill Effluent Dissolved Oxygen Concentrations

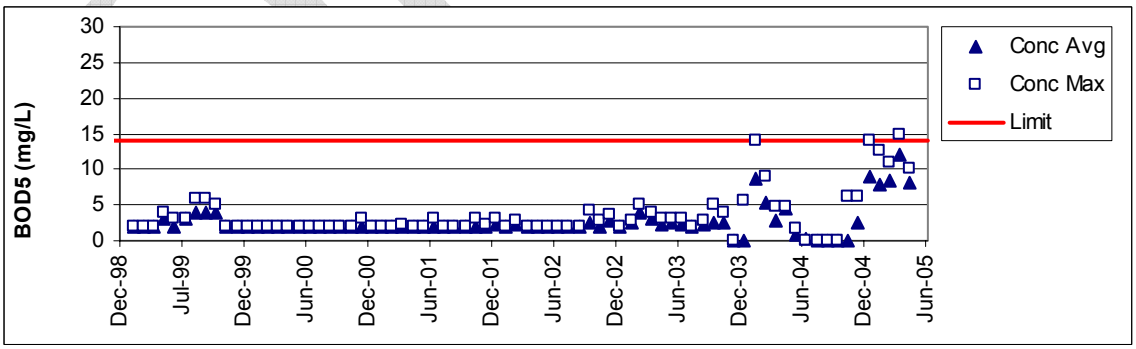

Figure 3-15: Vint Hill Effluent BOD Concentrations

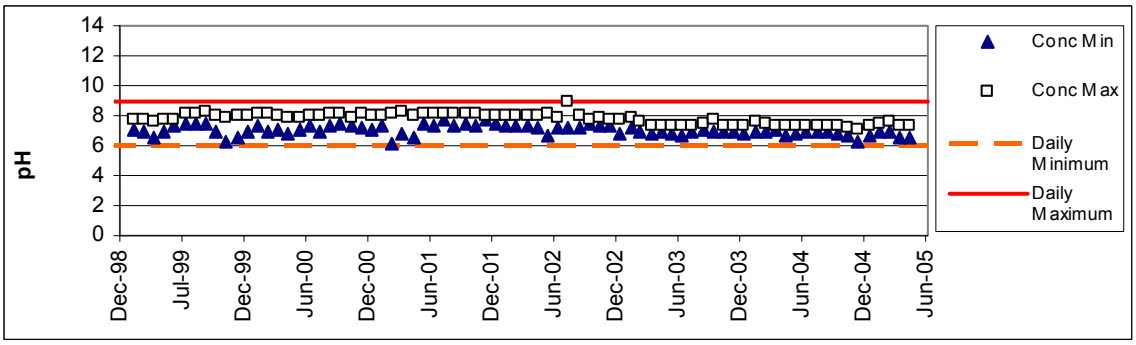

Figure 3-16: Vint Hill Effluent pH Values

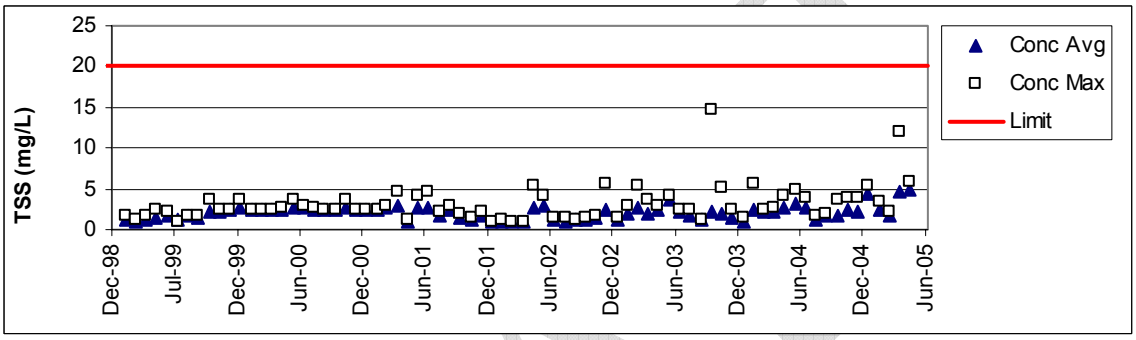

Figure 3-17: Vint Hill Effluent Total Suspended Solids Concentrations

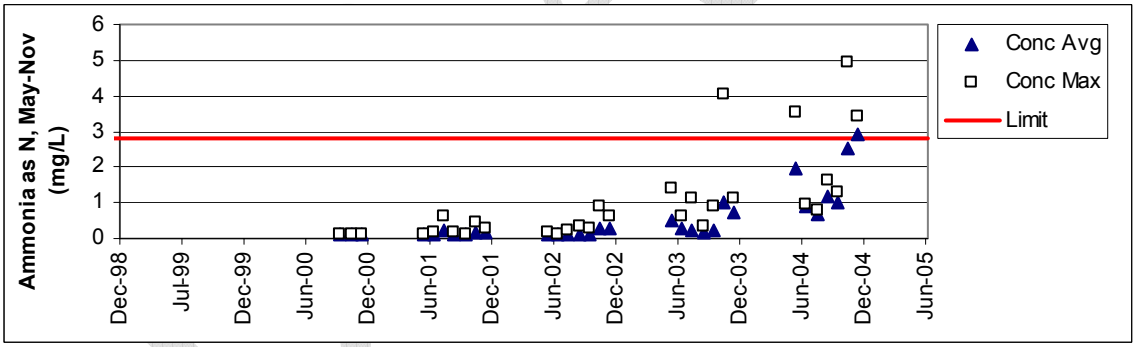

Figure 3-18: Vint Hill Effluent Ammonia Concentrations

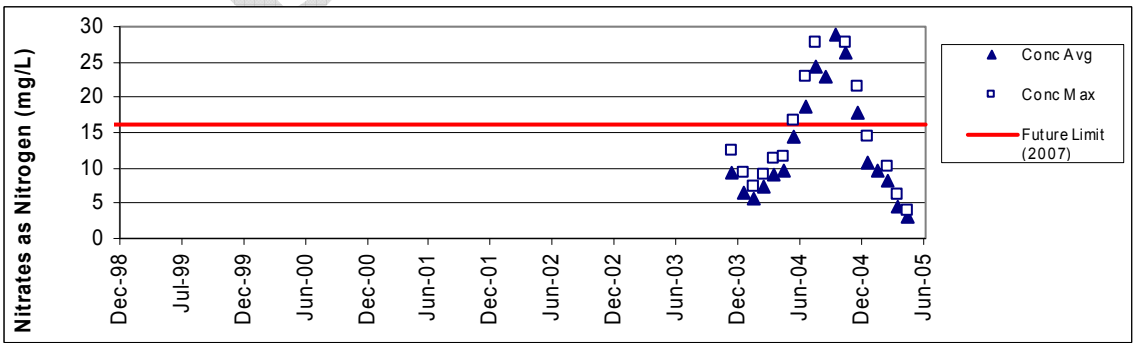

Figure 3-19: Vint Hill Effluent Nitrate Concentrations

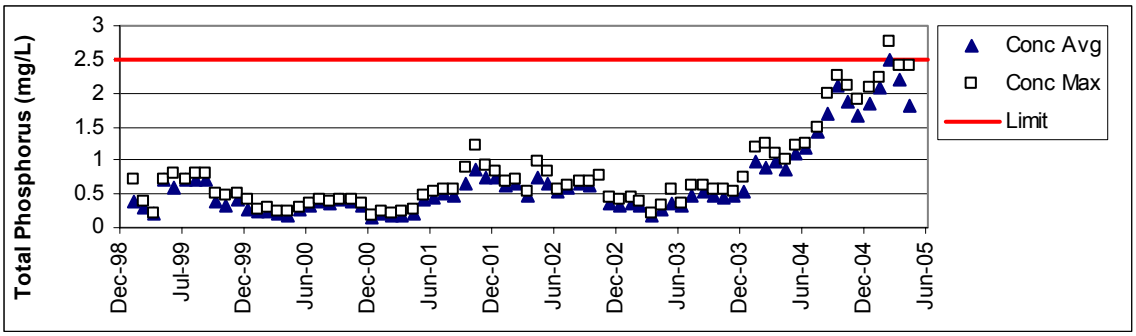

Figure 3-20: Vint Hill Effluent Phosphorus Concentrations

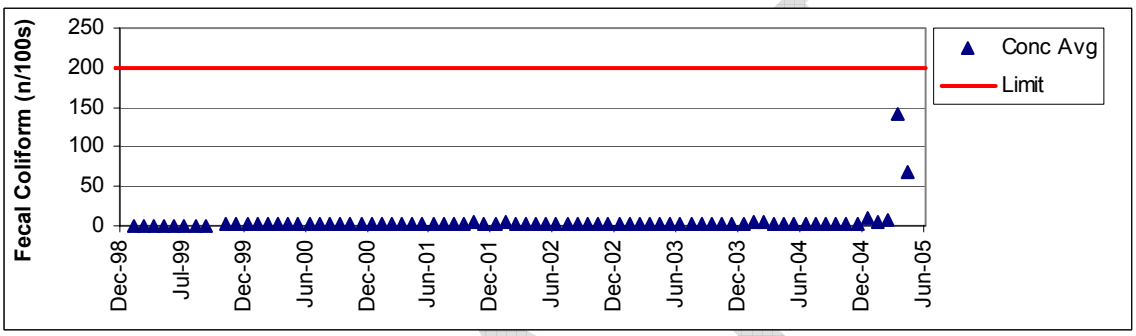

Figure 3-21: Vint Hill Effluent Fecal Coliform Concentrations

4.0 Stressor Identification Analysis

TMDL development for benthic impairment requires identification of pollutant stressor(s) affecting the benthic macroinvertebrate community. Stressor identification for the biologically impaired segment of the South Run watershed was performed using the available environmental monitoring and watershed characterization data discussed in previous sections. The stressor identification follows guidelines outlined in the EPA Stressor Identification Guidance (EPA 2000).

The identification of the most probable cause of biological impairment in the South Run watershed was based on evaluations of candidate stressors that can potentially impact the river. The evaluation includes candidate stressors such as pH, temperature, dissolved oxygen, sediment, ammonia, flow modification, and toxic compounds. Each candidate stressor was evaluated based on available monitoring data, field observations, and consideration of potential sources in the watershed. Furthermore, potential stressors were classified as:

Non-stressors: The stressors with data indicating normal conditions and without water quality standard violations, or without any apparent impact

Possible stressors: The stressors with data indicating possible links, however, with inconclusive data to show direct impact on the benthic community

Most probable stressors: The stressors with conclusive data linking them to the poorer benthic community. **Table 4.1** summarizes the results of the analysis.

Table 4.1: Summary of Stressor Identification in the South Run Watershed

Parameter	Location in Document
Non-Stressors	
Temperature and pH	Section 4.1.1
Organic Chemicals	Section 4.1.2
Dissolved Oxygen	Section 4.1.3
Possible Stressors	
Metals (Silver and Arsenic)	Section 4.2.1
Toxicity	Section 4.2.2
Most Probable Stressors	
Organic and Nutrient Enrichment	Section 4.3.1

4.1 Non-Stressors

4.1.1. Temperature and pH

Benthic invertebrates require a suitable range of temperature and pH conditions. Although these ranges may vary by invertebrate phylogeny, high instream temperature values and either very high or very low pH values may result in a depauperate invertebrate assemblage comprised predominantly of tolerant organisms.

Virginia Class III water quality standards identify the acceptable pH and temperature ranges for South Run to protect aquatic communities and habitats. Field measurements show that there have been no observed violations of water quality standards for temperature (**Figure 3-4**). A few exceedences of the minimum pH standard were recorded in 2001, and one exceedence of the maximum pH standard was recorded in 2005 (**Figure 3-6**). Therefore, temperature and pH are not anticipated to be adversely impacting the benthic communities in the South Run and are classified as non-stressors.

4.1.2. Organic Chemicals

Dissolved organics parameters (aldrin, dieldrin, endosulfan, endrin, DDD, DDE, DDT, PAHs, and PCBs) did not exceed acute or chronic dissolved freshwater criteria specified in Virginia's water quality standards. Organics concentrations were below detection limits for almost all of the samples analyzed.

Additionally, none of the available sediment organics data exceeded the sediment screening values specified in the DEQ 2004 assessment guidance memorandum.

Therefore, organic compounds are not anticipated to be affecting the benthic macroinvertebrates in the South Run, therefore are classified as non-stressors.

4.1.3. Dissolved Oxygen

Adequate dissolved oxygen (DO) levels are necessary for invertebrates and other aquatic organisms to survive in the benthic sediments of rivers or streams. Decreases in instream oxygen levels can result in oxygen depletion or anoxic sediments, which adversely impact the river's benthic community.

Field dissolved oxygen data presented in **Figure 3-2** indicates adequate DO levels in the impaired segment of the South Run watershed. Similarly, the DO diurnal study conducted between August 3 and August 5, 2005 shows that DO levels remained above the minimum DO standards (**Figure 3-3**). However, it should be noted that the study also shows a large diurnal DO swing of approximately 4 mg/L which is indicative of streams with high biotic production and the presence of eutrophication processes. These processes are generally caused by excessive nutrient loads.

In summary, despite the presence of diurnal DO swings and eutrophying conditions, the data show adequate levels of DO in South Run. Therefore, DO does is not anticipated to be directly affecting the benthic communities in the South Run and is considered a non-stressor.

4.2 Possible Stressors

4.2.1 Metals (Silver and Arsenic)

All available dissolved metals data (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc) were below the acute or chronic dissolved freshwater criteria specified in Virginia's aquatic life use standards. Sediment screening values in both 2001 and 2004 exceeded the consensus based probable effects concentration (PEC) sediment screening value for silver. In addition, fish tissue data in 2001 revealed an exceedance for arsenic. VADEQ's 303(d) fact sheets stated that observed effects on the aquatic community were noted in reference to these exceedences (2004). However, fish tissue samples taken in 2004 did not result in any exceedences of any metal concentrations.

The likely source of these metals found in South Run is from the Vint Hill Farms Station (VHFS). During World War II, VHFS served as a refitting station for units returning from combat before overseas deployment. In 1961, the U.S. Army Electronic Material Readiness Activity was moved to VHFS. In 1973, U.S. EPA took over operation of the photographic interpretation center from the Defense Intelligence Agency which was renamed the Environmental Photographic Interpretation Center (EPIC). VHFS went under the Major Subordinate Command of Communications-Electronics Command

(CECOM) and was named to the Base Realignment and closure (BRAC) list in 1993 (EPA, 2005). The photographic processing and military construction that took place at Vint Hill in the past is a likely source of metals found in South Run. Since silver and arsenic are no longer being discharged from Vint Hill, the levels of these metals in the ecosystem should continue to decrease. Since these metals were detected within South Run, they are classified as possible stressors.

4.2.2 Toxicity

Ammonia levels, which are toxic to aquatic organisms in high concentrations, were low across all monitoring stations suggesting that ammonia is not adversely impacting benthic invertebrates in the biologically impaired segments of South Run watershed.

Toxicity testing was performed on water samples collected on South Run by DEQ on April 12th, 14th, and 16th, 2004 and on May 2, 2005 at station 1ASOT001.65 Results indicated that there were no toxic water column effects to *Ceriodaphnia* in the South Run samples taken in 2004 and 2005. However, fathead minnow survival did vary from minnow survival in the control samples indicating the presence of toxicity in the South Run water samples taken in 2004 and 2005.

The EPA Region 3 laboratory in Wheeling, WV reported that, in their professional judgment, the difference in mortality rates between the samples taken at station 1ASOT001.65 and the control was "*probably biologically significant*." However, in both instances, the laboratory emphasized that these results were qualitative in nature, and needed to be compared to other available water quality data.

At present, review and assessment of the available water quality data provides no direct link to a potential toxic substance. However, the fish tissue and sediment metals data identified that there is a potential toxic effect in South Run. The toxicity testing results are insufficient to suggest that there is a toxicity affect directly impacting the benthic community, and therefore instream toxicity is only considered a possible stressor in the impaired segment of South Run.

4.3 Most Probable Stressors

4.3.1 Nutrient and Organics Enrichment

Excessive nutrient inputs can lead to eutrophication (algal blooms) and low dissolved oxygen concentrations, which may adversely affect the survival of benthic macroinvertebrates. In particular, dissolved oxygen levels may become low during overnight hours due to respiration. Similarly, excessive organic matter can lead to low in-stream dissolved oxygen concentrations that may adversely affect the survival and growth of benthic macroinvertebrates. Potential sources of nutrients include runoff from urban and agricultural areas and point source dischargers. Potential sources of organic matter include wastewater discharges, agriculture land use, and urban runoff.

Although the diurnal dissolved oxygen data did not show an exceedence of the minimum standard it did show daily DO swings indicative of high levels of biotic production and the presence of eutrophication processes related to excessive nutrient loads. This suggestion is supported by DEQ field biologists who noted that excessive filamentous algae, commonly caused by the use of fertilizers with a high nutrient content, are present in South Run. In addition, organic enrichment in South Run is confirmed by a lower EPT taxa count and consistently high MFBI scores, which are indicative of a relatively tolerant community and of organic enrichment. This has been specifically noted in the biologist's field notes which stress that the "s*ite is frequently dominated by a facultative and tolerant community which is indicative of organic enrichment"*.

In conclusion, the stressors with conclusive data linking them to the poorer benthic community are the organic and nutrient enrichments. Consequently, these are classified as the most probable stressors causing the habitat alterations in the South Run watershed.

4.4 Stressor Identification Summary

The data and analysis presented in this report indicate that dissolved oxygen, temperature, and pH, in the biologically impaired segment of South Run are adequate to support a healthy invertebrate community, and are not stressors contributing to the benthic

impairment. In addition, concentrations of organic-chemicals were generally low, or below analytical detection limits, and are classified as non-stressors.

The instream toxicity testing suggested the presence of potential toxicity in South Run. However, the toxicity data is still inconclusive, due to a lack of support for a toxicity effect in the available water quality data. As a result, instream toxicity is considered only as a possible stressor in the impaired segment of the South Run watershed.

Based on the sediment and fish tissue data, silver and arsenic are also classified as possible stressors. The photographic processing and military construction that took place at Vint Hill in the past is a likely source of silver and arsenic. Since silver and arsenic are no longer being discharged from Vint Hill, the levels of these metals in the ecosystem should continue to decrease.

Based on the evidence and data discussed in the preceding sections, nutrient and organic enrichments have been identified as the primary stressors impacting benthic invertebrates in the biologically impaired segment of South Run. Potential sources of organic and nutrient in the watershed include urban stormwater runoff, agricultural runoff, and point source dischargers, as well as Lake Brittle, which is probably contributing to the nutrient enrichment in the impaired segment of South Run.

Improvement of the benthic community in the biologically impaired segment of the South Run watershed is dependent upon controlling the organic and nutrient loads. To address these issues, an organic and nutrient enrichment TMDL will be developed for the biologically impaired segment of the South Run watershed.

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